COIL WINDING MACHINE

SARINA BINTI SHAFIE

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Faculty of Manufacturing Engineering
UNIVERSITI MALAYSIA PAHANG

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ABSTRACT

A coil winding machine is a machine for winding coil onto a spool, bobbin and many more. This coil winding machine is one of types of winding machine that available in industries today. From multi speeded machines to medium, large and extra-large machines, these machines come in various types and categories, performing a range function. The common applications for a coil winding machine are to wind coils for transformer, inductors, motor and chokes. To complete a coil using manual coil winding machine will be inconvenience and waste of time. Therefore, fabrication of coil winding machine will be done in this project which is controlled by two stepper motor using Arduino program. This machine is inexpensive, easy to operate and build in a small-scale size. This project also can be used for training students in winding of small transformers & relay coils.

ABSTRAK

Sebuah mesin penggulungan gegelung mesin penggulungan gegelung ke kili, sepul dan banyak lagi. Ini mesin penggulungan gegelung adalah salah satu jenis mesin yang terdapat di industri pada hari ini. Dari mesin yang mempunyai pelbagai kelajuan kepada mesin sederhana, besar dan lebih besar, mesin ini datang dalam pelbagai jenis dan kategori, melakukan fungsi pelbagai. Aplikasi biasa untuk mesin penggulungan gegelung adalah untuk menggulung gegelung untuk pengubah, peraruh, motor dan ‘‘chokes’’. Untuk melengkapkan gegelung menggunakan manual gegelung mesin penggulungan akan menyukarkan dan membuang masa. Oleh itu, dengan mencipta gegelung mesin penggulungan akan dilakukan dalam projek ini akan dikawal oleh dua motor dan menggunakan program Arduino. Mesin ini adalah murah, mudah untuk beroperasi dan membina dalam saiz yang kecil. Projek ini juga boleh digunakan untuk melatih pelajar dalam penggulungan pengubah kecil & gegelung geganti.

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τ_1	Force length ratio
Θ	Angle in radians
T	Tension
A	Sectional area
Y	Yield strength material
V	Velocity
π	Pi

LIST OF EQUATIONS

CHAPTER 1

INTRODUCTION

1.1 Background information

Typically, a winding machine winds a material such as metal wire, thread, or paper, onto a core, spool, or bobbin. There are several different types of winding machines, from simple manual feed machines to complex computer-numeric-control (CNC) machines. Some of the more common uses for winding machines are coil winding, rope winding, and continuous filament winding. Many industries use these devices, including textile, electronics, and wire industries. A manual winding machine usually has a core on a spindle and the user feeds wire, rope, or other material onto the core. The user controls the spindle speed and feeds the material through user hand, guiding it to control the tension and load pattern. These simple machines may be of a bench-top size or large stand-alone winder.

A coil winding machine is a machine for winding coil onto a spool, bobbin and many more. This coil winding machine is one of types of winding machine that available in industries today. The coil winders can be classified according to their speed levels and capacity. From multi speeded machines to medium, large and extra-large machines, these machines come in various types and categories, performing a range function. The common applications for a coil winding machine are to wind coils for transformer, inductors, motor and chokes. Coil winding machine design is dictated by a coil's complexity, material tension limitations, machine versatilities, and automation / operator intervention, production volume and budgetary considerations [3]. Complete types of winding machine ideal for educational institutes, small and medium enterprise.

1.2 Problem Statement

To complete a coil using manual coil winding machine will be inconvenience and waste of time. Furthermore, to have a good quality of automatic coil winding machine requires expensive tools and not user-friendly. Therefore, fabrication of coil winding machine will be done in this project which is controlled by two stepper motor using Arduino . This machine is inexpensive, easy to operate and build in a small-scale size. This project also can be used for training students in winding of small transformers & relay coils.

1.3 Objectives of the project

Basically these projects are listing three main objectives. The objectives are a guideline in order to complete this project. This project is conducted to achieve the following objectives:

i. To design and build a coil winding machine that has a small-scale and at a lower cost.
ii. To create a program that control stepper motor movement by using Arduino.
iii. To be a learning tool for student to wind a small solenoid and transformer.

1.4 Scope of Project

Project scope is the part of project planning that involves determining and documenting a list of specific project goals, deliverables, tasks, costs and deadlines. In this project, the scope of the project is including a design and fabrication a small-scale coil winding machine at a lower cost. In this project, the coil winding machine size will be only in desktop size. All the programming and coding project will be using Arduino program to control two stepper motor motion. Some of the coils winding machine components are available at the faculty laboratory such as stepper motor, aluminium plate, and lead screw. Certain component such as round bobbin, guide pulley and motor coupling is fabricated using rapid prototyping machine.

1.5 Flow chart

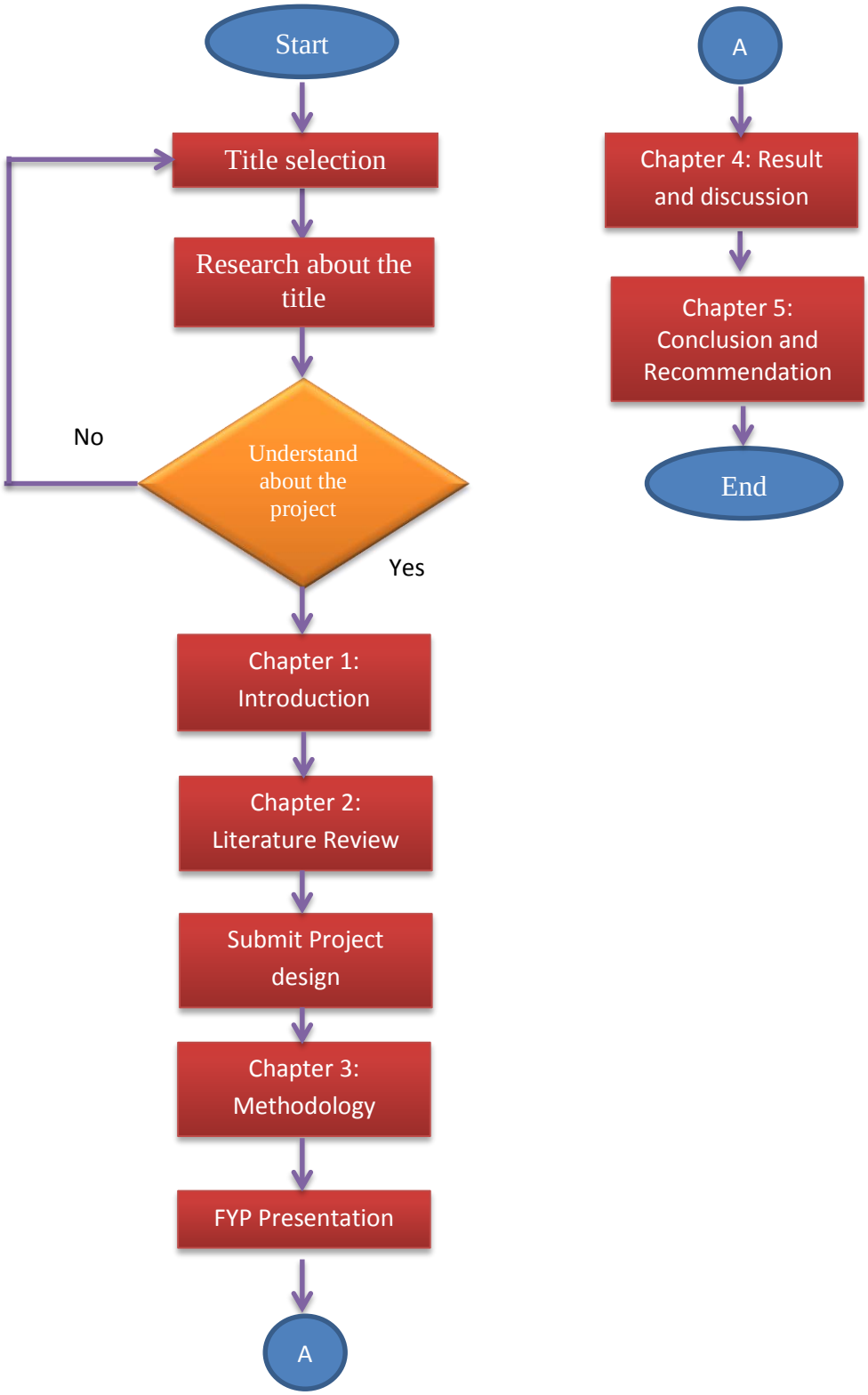

Figure 1.1: Flow chart

1.6 Thesis Overview

Coil Winding Machine final thesis is a compilation of 6 chapters that contains and elaborates specific topics such as the Introduction, Literature Review, Methodology, Architecture, Result and Analysis, Conclusion and Further Development that can be applied in this project.

i. Chapter 1: Introduction

This Chapter 1 is an introduction which is the overview of the project, objective of the project, problem statement, scope of project and project flow chart through this semester.

ii. Chapter 2: Literature review

This Chapter 2 content about literature review on comparison between round and rectangular bobbin, method of windings coil, also a research about importance of tension in coil winding machine, function and advantage of stepper motor, Visual basic and Parallel port connection.

iii. Chapter 3: Methodology

This chapter will explain about the project methodology through this project. Project Flow chart, block diagram, project component, operation flow and visual basic programming.

iv. Chapter 4: Result and discussion

Discuss all the results obtained and the limitation of the project. All discussions are concentrating on the result and performance of the coil winding machine.

v. Chapter 5: Conclusion

Discuss the conclusion about the project from the beginning until the end. Also conclude all the advantage and disadvantage through the project for further improvement.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews about previous studies to fabricate coil winding machine. Before any project was started, proper and deep analysis is required to understand the basic function of the system. From that analysis, appropriate and suitable components and method can be selected to deal with the project function.

The objectives of this chapter are:

- To determine which method are appropriate to use to winds a coil.
- To identify the importance of tension control in coil winding machine.
- To ensure that stepper motor and Arduino program are suitable for this project.

2.2 Comparison between round and rectangular bobbin

There are various types of bobbin that being used in coil winding machine nowadays. The shapes of bobbin are important to winding a coil. The shape of the coil being wound has a significant impact on the quality of the tension applied by the tensioner [7]. Most of them are round bobbin and rectangular bobbin. From the previous study, many of them prefer round bobbin compare to rectangular bobbin. It because the round shapes on the round bobbin allows a uniform round when winding a coil. Compare with rectangular coil, the coil tend to breaks up because of the shape itself causing the coil windings become uneven. Besides that, rectangular coil is hard to maintain the tension control. Tension device must be absorb and maintain the control when handling a

rectangular bobbin which applies 4 impacts points per revolution. In addition, rectangular coil winding speed are very limited.

As the coil turns on the winding machine shaft, the speed of the wire feeding onto the coil accelerates and decelerates as a rectangular coil is being wound. As shown in figure below, due to the continuously altering wire path length the speed become vary. Round bobbin does not have a problem with this because the wire contact point on the coil is fixed.

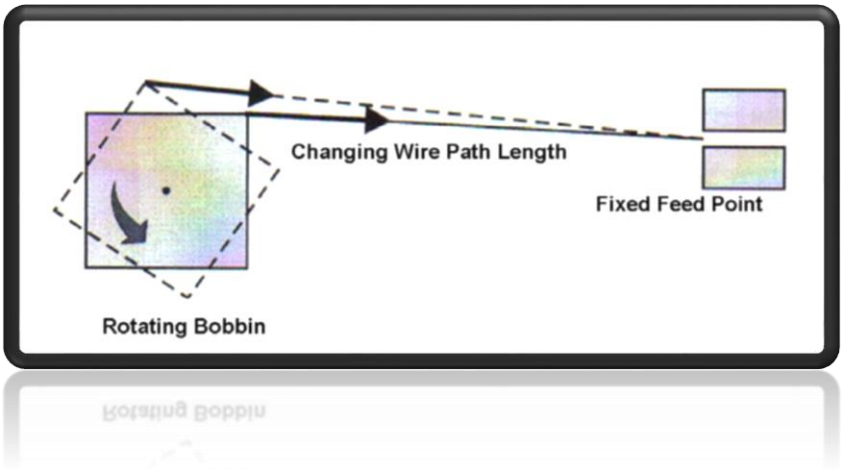

Figure 2.1: Acceleration due to the changing wire path length during winding [7].

2.3 Method of windings coil

The coordination of rotational and translational motions is necessitating when transferring wire to bobbin. There are many methods to winds a coil nowadays. Previous study shows there are two of the most common methods of winding coils are spindle winding and fly winding. In the spindle winding process, the coil is wound by rotating its core or bobbin. In the fly winding process, the bobbin is fixed and the wire is wrapped around it [2]. Spindle winding are easiest compare to fly winding process because it can control the wire position uniformly and smooth compare to fly winding. Fly winding are tend to get twisted because of inconsistent twisting and inaccurate wire displacement. The centripetal force in spindle winding machine wire tension is required to rotate the wire in circular path. It leads to a looser coil and reduces the coil tightening forces. If there is less reduction, spindle winding are desirable because of the ability to control the wire position.

2.4 Importance of tension in coil winding machine

Tension is the force required to pull the wire against the accumulation of all resistance, forces and loads imposed on the wire as it moves, including the tension device [5]. Consistent tension is important to achieving the aim of coil electrical characteristics also stable performance from coil to coil. Pretension is when the force applies to the wire path before and after tension device. Pretension is caused by the friction of the wire moving over pulleys, supply spool flange and many more. There are two types of tension state which is static and dynamic state. In dynamic state, the tension started when the wire meets the bobbin or the previous winding of the coil. Tightness and compactness of the coil are controlled by the tension.

Consistent tension is required during coil winding. Among the winding tension factors including bobbin size, bobbin shape, number of turn, winding speeds, acceleration and deceleration rates. No matter how sophisticated the motor controls has, the material easily to get wander during winding and causing irregular spaced turns when insufficient tension occur. The diameter of the wire will reduce hence reducing the strength of the wire and make the wire tends to breakage if there is too much tension. Other than that,

excessive tension can cause to change the wire characteristics and damage the bobbin's surface during winding process. Major characteristic of coil is resistance. Coil that randomly wounds in the same number of turn will produce different wire lengths. . If a coil is wound with good tension it is compact and it has less wire on it then a coil wound with incorrect low tension that results in a coil with longer total length of wire [5].The longer the coil wire has, the higher the resistance of the coil.

Control the speed of the winding is also included in tension control techniques. Basic winding speed tension control is shown in figure 2.4.1 below. The wire tension through a tension pulley connected to a spring will continuously monitored by the system. The position of the pulley is output to a controller which compares this tension with the preset tension and drives the motor accordingly, speeding up for a drop and slowing down for an increase in tension [7].

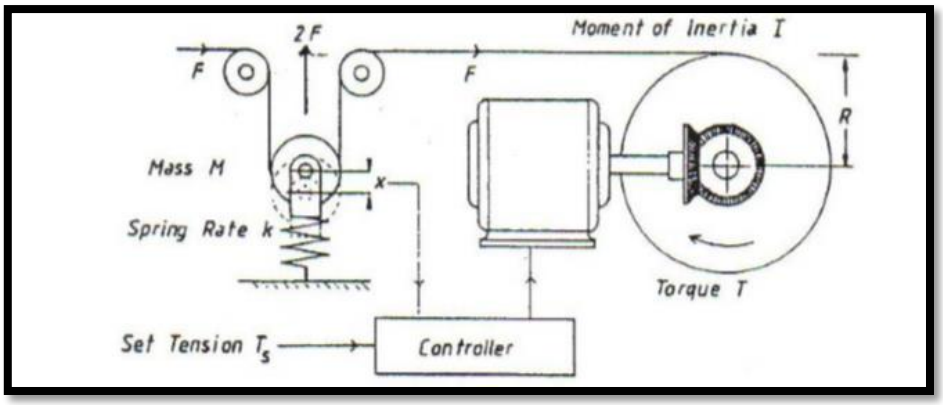

Figure 2.2: Basic winding speed tension control system [7].

2.5 Function and advantages of Stepper motor

Stepper motor is brushless, synchronous electric motor that converts digital pulses into mechanical shaft rotation. There are two types of stepper motor which is bipolar and unipolar. In this project, unipolar stepper motor will used to move the carriage that controls the coil position and the round bobbin. The unidirectional and unipolar stepper motor will become outstanding as the result of its low costs, stable performance, suitable for computer control and could be driven by unipolar stepper motor [1]. Besides that,

there are additional advantages of stepper motor such as low inertia, large torque and high respond frequency.

The advantages of stepper motors over stopple AC or DC motors include no feedback requirement for position or speed control (open loop operation), noncumulative positional errors, precise electronic speed control using digital technology and compact size for driving large loads at low speeds [6].

The rotary motion of stepper motor can be converted to linear motion using a lead screw drive system as shown in figure below. The lead, or pitch, of the lead screw is the linear distance traveled for one revolution of the screw. If the lead is equal to one inch per revolution, and there are 200 full steps per revolution, then the resolution of the lead screw system is 0.005 inches per step.

2.6 Arduino with Stepper motor

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicate with software running on your computer (e.g. Flash, Processing, MaxMSP.) Stepper motors fall somewhere in between a regular DC motor and a servo motor. They have the advantage that they can be positioned accurately, moved forward or backwards one 'step' at a time, but they can also rotate continuously.

The Arduino programming environment is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with the look and feel of Arduino. [8]

CHAPTER 3

METHODOLOGY

3.1 Introduction

In developing a project, methodologies is one of the most important element to be consider to make sure that the development of the project is smooth and get the expected result. A good methodologist can be described the structure or the flow of the project where by it can be the guideline in managing it. It is also to avoid the project to alter course from the objectives that have been started or in order words the project follow the guideline based on the objectives.

In this chapter, the methodology is divided into three parts which is mechanical, electrical and programming coding.

3.2 Project Flow chart

Flow chart of work methodology can be simplified as shown in Figure 3.1.

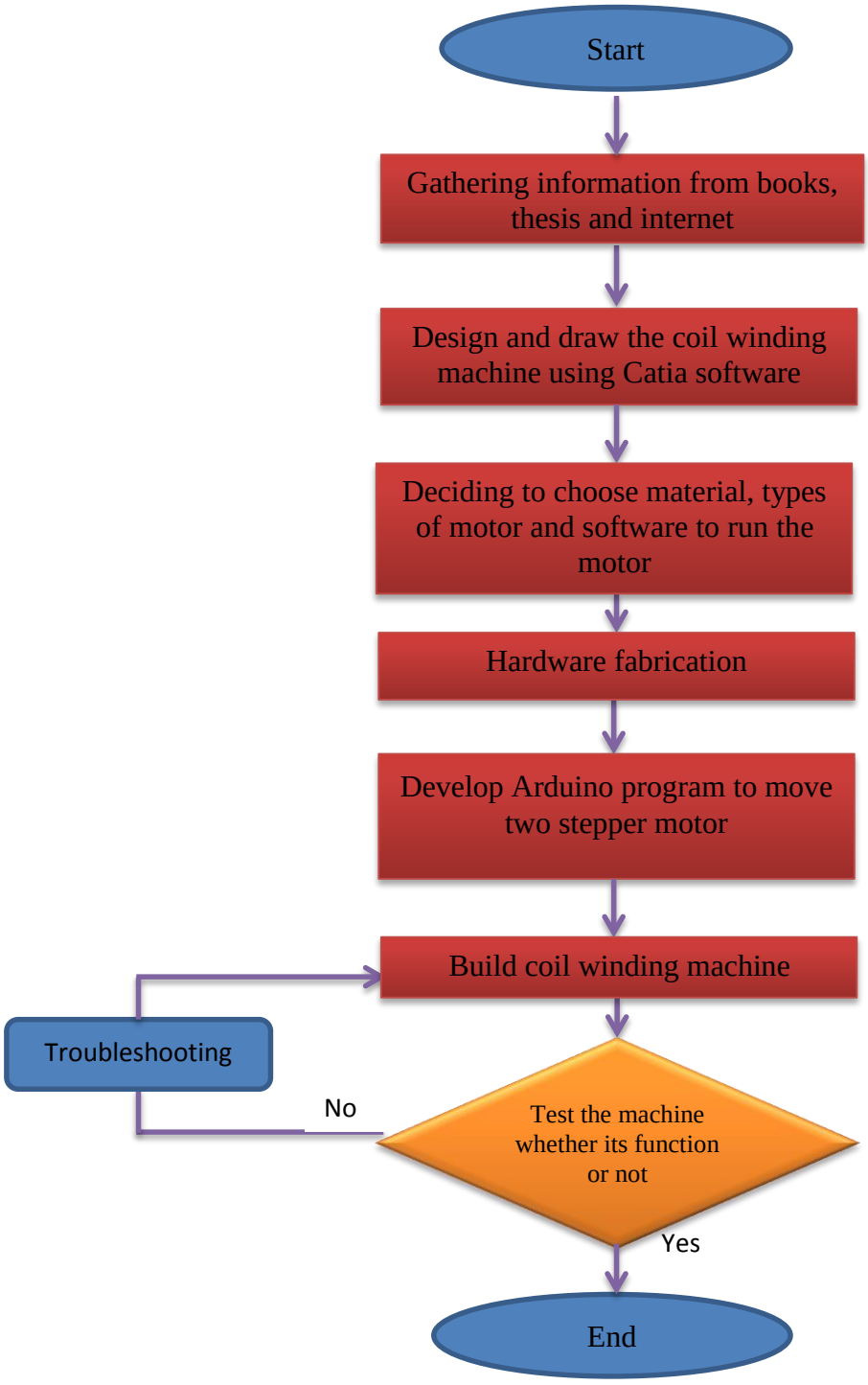

Figure 3.1: Flow chart of Methodology

3.3 Block diagram

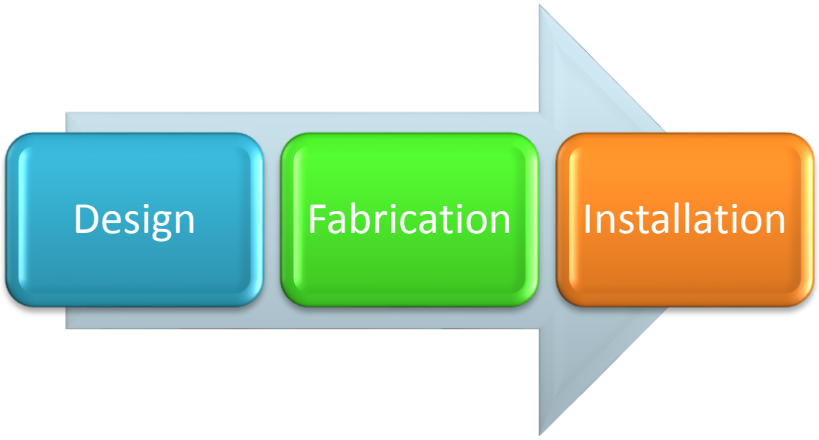

Figure 3.2: Process block diagram

As shown in a block diagram above, there are three important steps to execute this project, which are design, fabrication and installation. Design in the crucial part before fabrication. Without a proper design this project cannot proceed to another step and to fulfil this project. After researching in journals, books and internet on how to design a good quality of coil winding machine, the design have drawn using Catia software. After completing the project drawing, then do a selection for which material are suitable to fabricate.

Types of motor and types of program to control motor motion are also included in the selection. After done with the selection, the next step is fabrication. On fabrication, there are divided into two sections, which is hardware and software. Hardware also divided into two parts which is mechanical and electrical. Arduino program will be used in this project to control the motion of the motor and parallel interface as the connector between the hardware and the software. The final steps are installation. In installation process, the hardware and the software will be installed together to build a coil winding machine.